



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
Group Art Unit 3736

In re
Patent Application of
Mark G. Fleischhacker
Serial No. 09/770,342
Confirmation No. 6291
Filed: January 26, 2001

Examiner: Marmor II, Charles Alan
"NON-METALLIC GUIDE WIRE"

I, Leslie Rector, hereby certify that this correspondence
is being deposited with the US Postal Service as first
class mail in an envelope addressed to Commissioner
for Patents, P.O. Box 1450, Alexandria, VA 22313-
1450, on the date of my signature.

Leslie Rector
Signature

September 8, 2003
Date of Signature

92883
#15

DECLARATION UNDER 37 C.F.R. 1.131

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

The undersigned, Mark G. Fleischhacker hereby declares and states:

1. THAT I am the inventor of the subject matter of all the claims of the above-identified U.S. patent application, as filed. I have assigned all rights, title and interest in the above-cited invention to Lake Region Manufacturing, Inc. ("Lake Region"). I am the Chief Operating Officer of Lake Region. I co-manage a \$90 million + business of making medical devices and spend but a small portion of my time in product development. This Declaration is submitted in furtherance of prosecution of the above-cited application.

2. THAT all statements made herein based upon my own knowledge is true, and all statements made on information and belief are believed to be true.

3. THAT this Declaration under 37 C.F.R. § 1.131 is, specifically, being filed to overcome International Publication Number WO 01/95794, Applicant Cordis Corporation (hereafter “the Cordis reference”) having an effective date of as early as June 12, 2000. The Cordis reference is cited as the primary reference under section 102(e) and 102(e)/103(a) for rejecting claims 1-18 in an Office Action mailed 03/06/2003. I have not reviewed the June 12, 2000 priority document (60/211,157 U.S.). Nothing in this declaration is to be construed as expressing a belief or conclusion that U.S. provisional application 60/211,157 adequately discloses the substance of the Cordis reference so as to be the basis for any claim of priority.

4. THAT prior to June 12, 2000 I conceived and diligently worked to reduce to practice in this country, the invention described in the subject application and as defined in claims 1-18, as evidenced by the following:

- a. I first disclosed my concept of what became the subject of the referenced patent application to Lake Region's patent counsel, Grady J. Frenchick several years before the June 12, 2000 priority date of the Cordis reference. Evidence of disclosure is attached as Exhibit 1. The dates have been removed from Exhibit 1 in accordance with PTO practice. A separate inquiry about an unrelated legal matter also has been redacted.
- b. I supplemented my initial disclosure with a subsequent memo dated a little over 2 months later (Exhibit 2, attached), but more than a year before June 12, 2000.
- c. Subsequent to the disclosure noted in the preceding paragraph, about 4 months later, a first draft of what became the subject application was

generated by our patent counsel Grady Frenchick and sent to me. The first draft was many months before the June 12, 2000 priority date of the Cordis reference. A date-redacted version of the first draft is attached as Exhibit 3. The handwriting was put on this draft after its date and is not mine.

- d. About 2 months later, I provided my comments to Attorney Frenchick regarding the draft application in the attached date-redacted memo noted as Exhibit 4.
- e. It is to be noted that the original concept (Exhibit 1) and the invention of Exhibit 4 are substantively the same. A second draft application (Exhibit 5) was generated and sent to me by our counsel, Grady Frenchick. The dates have been redacted. The handwriting was added after the date of the draft and is not mine. The date of the second draft is less than two weeks after the filing date of the Cordis references. Neither I nor anyone at Lake Region was aware of the Cordis reference at the time it was filed.
- f. About 2 months later I provided my comments regarding the second draft (Exhibit 6, dates removed) and provided further embodiments of the invention that were generically within the inventive concept.
- g. About 2 months later a third draft (Exhibit 7) of the application was generated and sent to me. Dates are removed.
- h. Further revisions were made to the application and it was then actually filed in the U.S. PTO about 2 months later on January 26, 2001.

5. THAT all statements herein of my own knowledge are true, that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like as made are punishable by fine or imprisonment or both under § 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: September 8, 2003


Mark G. Fleischhacker

EXHIBIT 1

Page 1 of 1
AC

LAKE REGION MANUFACTURING, INC.
340 Lake Hazeltine Drive, Chaska, MN 55318 USA
FAX: 612-368-3378 TELEPHONE: 612-448-5111

TO: [REDACTED] FAX: 608-283-2275
MICHAEL, BEST AND FRIEDRICH LLP

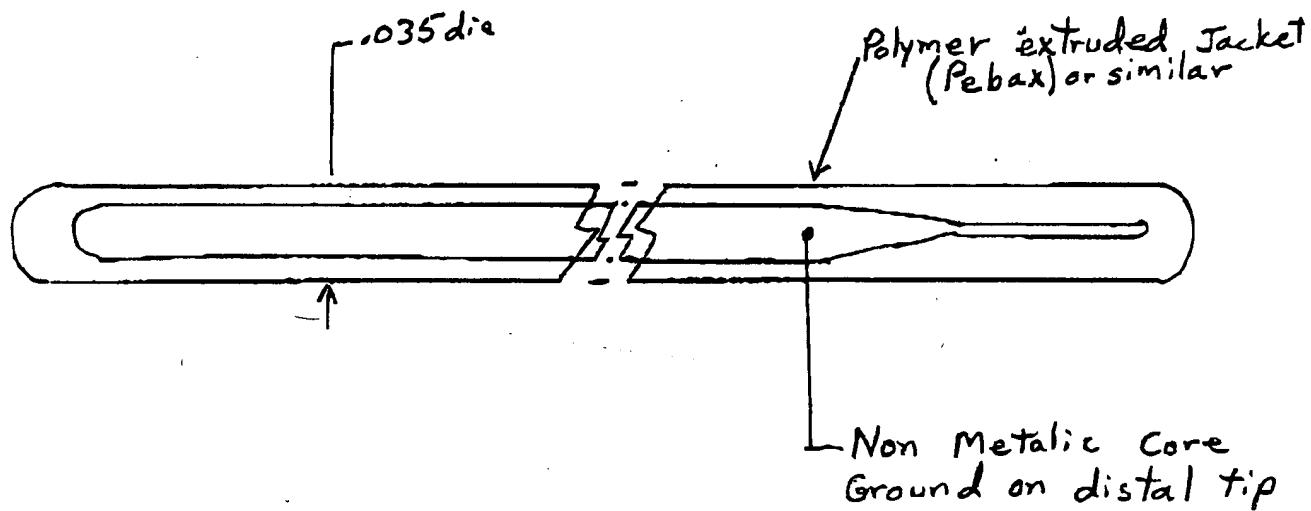
FROM: Mark Fleischhacker, President/COO

DATE:

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Dear Grady:

Secondly, I would like to know your thoughts regarding the patentability of a non-metallic guidewire, as drawn below.



Regards,

Mark Fleischhacker

Mark Fleischhacker

MF/sb

Drawn By: 9/22/02
Date:
MR. WIRE

EXHIBIT 2

Michael Best & Friedrich LLP
RECEIVED

LAKE REGION MANUFACTURING, INC.

340 Lake Hazeltine Drive, Chaska, MN 55318 USA
FAX: 612-368-3378 TELEPHONE: 612-448-5111 DOCKETING
MADISON, WI

TO: Grady Frenchick, Attorney at Law
MICHAEL, BEST & FRIEDRICH LLP **FAX:** 608-283-2275

FROM: Mark Fleischhacker, President/COO

DATE:

SUBJECT: Patent Application for a Non-Metallic MR (Magnetic Resonance)
Compatible Guidewire/Diagnostic/Angiographic Wire

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Dear Grady:

The proposed design for a wire includes a non-metallic core made from a polymer material or composite material such as nylon, glass-filled nylon, fiberglass resin-based composite, carbon fiber resin-based composite, polyamide, Peek and other polymers. This polymer or composite material shall have a high pull strength, good flexibility and preferably be kink-resistant or, at the very least, camber resistant.

The core could be the stand-alone element of the guidewire or could be coated with a polymer such as vinyl, nylon, Pebax or similar material with good durability and good size stability. The core or polymer would be coated with a lubricious coating such as MDX or hydrophilic. The wire would be designed to cover the diameters of .010"-.038" and lengths from 10" to 20'.

Sincerely,

Mark Fleischhacker

Mark Fleischhacker
President/COO

MF/sb

NON-METALLIC GUIDE WIRE**CROSS-REFERENCE TO RELATED APPLICATIONS**

5 Not Applicable

BACKGROUND OF THE INVENTION

Guide wires are used in various medical procedures to gain vascular or
10 non-vascular access to anatomical locations. The guide wire is initially
introduced into the anatomy of a patient by means of a needle or other access
device which in many procedures pierces the patient's skin. The guide wire
is then advanced to a chosen or targeted anatomical location to provide a
means of tracking guidance and support for other diagnostic, interventional,
15 or therapeutic medical devices having lumens which can follow or track over
a guide wire. Once such other medical devices reach their desired anatomical
location, the guide wire is or can be withdrawn. The physician then proceeds
with the protocol of the procedure. A specific but non-limiting example of
the above is the placement ~~of the balloon~~^{sup.} of a balloon catheter at the site of a
20 vascular blockage. Suffice it to say, guide wires are one of the most
commonly used medical devices where vascular or arterial access is desired.

United States patent 5,705,014 to Schenck et al. discloses and claims
methods for constructing instruments, specifically medical instruments,
intended for use during a magnetic resonance (MR) imaging procedure.
25 Essentially, the Schenck et al. '014 patent discloses methods for selecting
carbon fiber/substrate composite materials and for doping such composites
with materials of differing degrees of magnetization. In accordance with the
teaching of Schenck et al., the composite materials are doped so that medical
instruments manufactured from the doped composites do not interrupt the

MR imaging process or distort an image developed therefrom. The entirety of the disclosure of the Schenck et al. U.S. 5,705,014 patent is incorporated by reference herein.

insert A

A guide wire of the invention is non-composite.

5

BRIEF SUMMARY OF THE INVENTION

or non-composite

, and preferably is substantially
~~a~~*— solid.*

Briefly, in one aspect, the present invention is an elongate guide wire comprising a guide wire body or core wire, the body having coupled or connected distal, medial, and proximal segments. The guide wire body of

10 the present invention is substantially non-metallic, non-woven, ~~—~~ non-braided, and ~~preferably~~ is polymeric. In a preferred practice, a guide wire body of this invention is monofilament. A guide wire body of this invention, in a preferred practice, is substantially solid in cross-section throughout substantially its entire length. Guide wires of this invention are particularly 15 useable during MR diagnostic and therapeutic procedures. In addition a guide wire of the present invention is camber and kink or prolapse resistant, as well as being pushable, steerable, and torque transmissive. These terms will be more extensively defined below.

insert B
The term "guide wire" as used herein is to be broadly construed to 20 mean essentially any wire-like structure of dimension and length which is intended to assist in the placement of a catheter or other medical device at a site of medical interest. Percutaneous procedures in which placement of a catheter or other device through the skin and into the vasculature, are a preferred category of medical procedures in which guide wires are used.

25 Guide wires ^{ARE?} herein is intended to include but is not limited to what is usually referred to as a guide wire, a main wire, introducer guide wires, diagnostic, therapeutic or interventional guide wires, wire guides, and spring guide wires, but also includes exchange guide wires and extension wires. Dimensions of guide wires to which the present invention primarily applies fall in the range

of about 0.020 in. to about 0.065 in. in diameter and about 30 cm to about 300 cm (or more) in length. Without limiting the generality of the foregoing, peripheral, cerebral (including neuro-interventional), guide wires or wire guides are within the contemplation of this definition. Guide wires of the 5 present invention may include structure (e.g., on their extreme proximal segment) which permits them to be extended during a procedure by connection in a second (extension wire) guide wire. Guide wires of this invention also will generally have a reduced diameter, increased flexibility tip. Guide wires of this invention optionally may be coated or treated with 10 various further compositions, e.g., polymers or other compounds, to change their handling or performance characteristics such as to increase lubricity, or to reduce thrombogenicity of their external surface. Guide wires of the invention may also be uncoated.

to increase or decrease hydrophobicity

A guide wire of the present invention is said to be "non-metallic". This 15 term is intended to mean containing or comprising no metals, alloys, or other materials which respond in some manner to the magnetic or radio frequency fields generated in an MR imaging system. This definition is intended to exclude ^{any} non-ferrous metals which, while not necessarily interacting with the MR magnetic fields, exhibit what has become known as "antenna effect" by 20 interaction with the radio frequency fields used in that procedure. Thus magnetic field deflection and "antenna effect" are completely eliminated by the use of the present invention. A preferred class of materials which are non-metallic in accordance with this invention comprise polymeric materials. Polymeric materials useable in the present invention predominantly are 25 substantially comprised of the elements of carbon and hydrogen.

BRIEF DESCRIPTION OF THE FIGURE

FIG 1

The present invention will now be discussed in detail, the figures understanding of which will be enhanced by reference to the attached ~~FIGURE~~ FIGURE 5 which is a cross-sectional view (partially broken away) of one embodiment of the present invention:

*FIG. 2 is a second embodiment of the present invention;
FIG. 3 is a cross-section of the embodiment of the present invention shown in FIG. 2.*

DETAILED DESCRIPTION OF THE INVENTION

10 The invention will now be described with reference to the FIGURE noted above and the attached claims. The FIGURE shows a partially broken away, cross sectional view of one embodiment of the present invention. The FIGURE shows a guide wire 10 comprising a guide wire body or core wire 11 having a connected or coupled proximal segment 12, distal segment 14, 15 and a medial segment 16. It is to be understood that the medial segment will generally comprise the majority of the length of the guide wire 10 and has been broken as shown for purposes of illustrating other features of the invention. The terminology of proximal, medial, and distal, as it is used with reference to guide wire structures, will be well understood by one skilled in 20 this art to mean structures of the guide wire as determined from the user's perspective. More specifically, the distal segment 14 of a wire of this invention generally means that portion of the guide wire which first enters the patient's anatomy when the device is utilized. The distal segment 14 of any particular guide wire is generally designed to be more flexible than the rest of 25 the guide wire. In that regard, the distal segment 14 begins with a taper 13 in which the medial segment 16 of the guide wire body has a gradually reduced diameter. Taper 13 leads to distal segment 14 which, as shown in this embodiment has a lesser diameter than medial segment 16 or proximal

segment. Thus, distal segment 14 will generally be more flexible than medial segment 16.

The embodiment shown in the FIGURE includes an optional outer covering, coating, or jacket 17. Generally speaking jacket 17 will be a non-metallic polymeric material, the polymer of coating 17 being different from that of guide wire body 11. For example, one preferred polymer of coating 17 is PEBA~~X~~ polyetherimide. Polyurethane, nylon, polytetrafluoroethylene (PTFE) are further examples of optional coatings which could be used with the present invention. Extruded polymer coatings or other heat-shrunk polymer coatings also may be utilized. A variety of other hydrophilic, hydrophobic or other coatings are known to one skilled in this art can optionally be used with the present invention. ~~as is shown, in FIG. 1~~ coating or jacket 17 tends to make the overall diameter (arrows 15) of the guide wire more uniform. *Polymer coatings over*

Guide wire body 11 is non-metallic, and in a preferred practice, ~~polymeric, the overall diameter of the guide wire of at least~~ the medial segment shown in the ~~FIG. 1~~ (at arrows 15) is ~~approximately~~ ^{16?} 0.035 inches. Without ~~intending to limit the scope of the present invention, it is not preferred that the present invention be used to build coronary-sized guide wires i.e., guide wires having a diameter of about 0.020 inches or less.~~ A preferred polymeric material for guide wire body 11 polyetheretherketone, sold under the designation PEEK. PEEK as is used in accordance with this invention is commercially available from many sources. A preferred source is Zeus Industrial Products, Inc. in Orangeburg, South Carolina, U.S.A. ([HTTP://www.zeusinc.com](http://www.zeusinc.com)) PEEK is preferred for use in the present invention because it is camber resistant, having little tendency to break when sharply bent. It is also thermally stable permitting other polymeric materials to be extruded over it without change in dimension. PEEK is also ~~capable~~ ^{believed to be} of being impregnated with glass fibers, e.g., to ~~increase its longitudinal~~ ^{alter its} ~~stiffness.~~ "Camber resistant" herein means having the property or tendency *Handling characteristics.*

not be become curved when held in a circular package while being shipped. Camber resistance could also be described as not having the tendency to remain curved or circular even though guide wires are commercially shipped in circular carriers. The absence of camber means that medical personnel 5 using a device of this invention can remove it from its generally circular shipping tube (the device may have been maintained in a circular configuration for several months while the device was in inventory and being shipped) and still be immediately useable, e.g., for catheter placement.

Polyetheretherketone described above also has the property of not 10 being easily broken when sharply bent, e.g., around ~~the~~ human or other vasculature. PEEK also tends to resist prolapsing or to be kink resistant, i.e., becoming bent back upon itself. This is also an advantage of the use of PEEK to make the guide wire body of this invention. Last, as is noted above, the distal segment of a guide wire of the present invention is generally 15 more flexible than either of the proximal or medial segments. In this instance, the polymer used should preferably be capable of being centerless ground. Being capable of being centerless ground means that the reduced diameter distal segment (14 in the FIGURE) can easily be manufactured using conventional guide wire processing techniques. *insert C*

20 A second material from which guide wire body 11 can comprise is a carbon fiber polymer commercially available from ~~STL~~ in Germany. ~~[Aside to Mark: I attempted to find something about STL on the Internet. I was not successful. Do you have any more information about the company e.g., an address, the product, a technical bulletin, etc., so that 25 we can beef up this description of this class core wire of materials? gif]~~

The polymeric materials which have been found to be useful for fabricating the guide wire core wire or guide wire body have properties which are representative of the properties of any polymeric material from which a guide wire of this invention is to be fabricated. Specifically, the polymeric

material must have sufficiently longitudinally rigidity or stiffness so that the guide wire can be advanced within a patient's vasculature in much the same fashion as e.g., a conventional 0.035 in. (diameter) metal angiography wire. As is noted above, the material must also be camber resistant while also being 5 resistant to prolapsing. Last, a workable polymeric material must be capable of being fabricated to have properties and "feel" like conventional metal, e.g., medical grade stainless steel, guide wires.^{spell out?} In summary, polymeric materials from which the instant guide wire body or core wire can be fabricated are those that, with similar diameters, lengths, and coatings tend to perform in a 10 medical procedure substantially the same as their metallic counterparts.

It is to be noted that guide wire body 11 is substantially solid in section, substantially throughout its entire length. No interior lumens, or other void spaces are contemplated to be needed or necessary to practice the present invention presuming a polymeric material having the above 15 characteristics is selected to fabricate the guide wire body.

EXAMPLE

20 [Mark - Is there information from the University of Minnesota trial that we can insert here?]

Insert D

CLAIMS

WHAT IS CLAIMED IS:

- 5 1. A guide wire comprising a core wire having coupled distal, medial and proximal segments, the core wire substantially comprising a non-metallic, *non-woven, ~~non~~* material.
- 10 2. A guide wire according to claim 1 wherein the core wire distal segment has a diameter which is less than that of the core wire medial and proximal segments.
- 15 3. A guide wire according to claim 1 wherein the diameters of the core wire distal, medial, and proximal segments are all substantially the same.
- 20 4. A guide wire according to claim 1 wherein the core wire has a polymeric coating thereon which covers substantially the entire length of the guide wire.
- 25 5. A guide wire according to claim 1 wherein core wire has a tapered segment between the medial segment and the distal segment.
- 30 6. A guide wire according to claim 1 wherein the core wire further comprises a taper which couples the medial segment and the distal segment and wherein substantially the entire core wire is covered with a polymeric material.
- 35 7. A guide wire according to claim 1 wherein the core wire comprises a polymeric material.
- 40 8. A guide wire according to claim 1 wherein the core wire comprises a polymeric material and the core wire is ^{tense} substantially completely covered with a second polymeric material.
- 45 9. A guide wire according to claim 1 wherein the distal segment of the core wire has a diameter which is less than that of the medial segment.

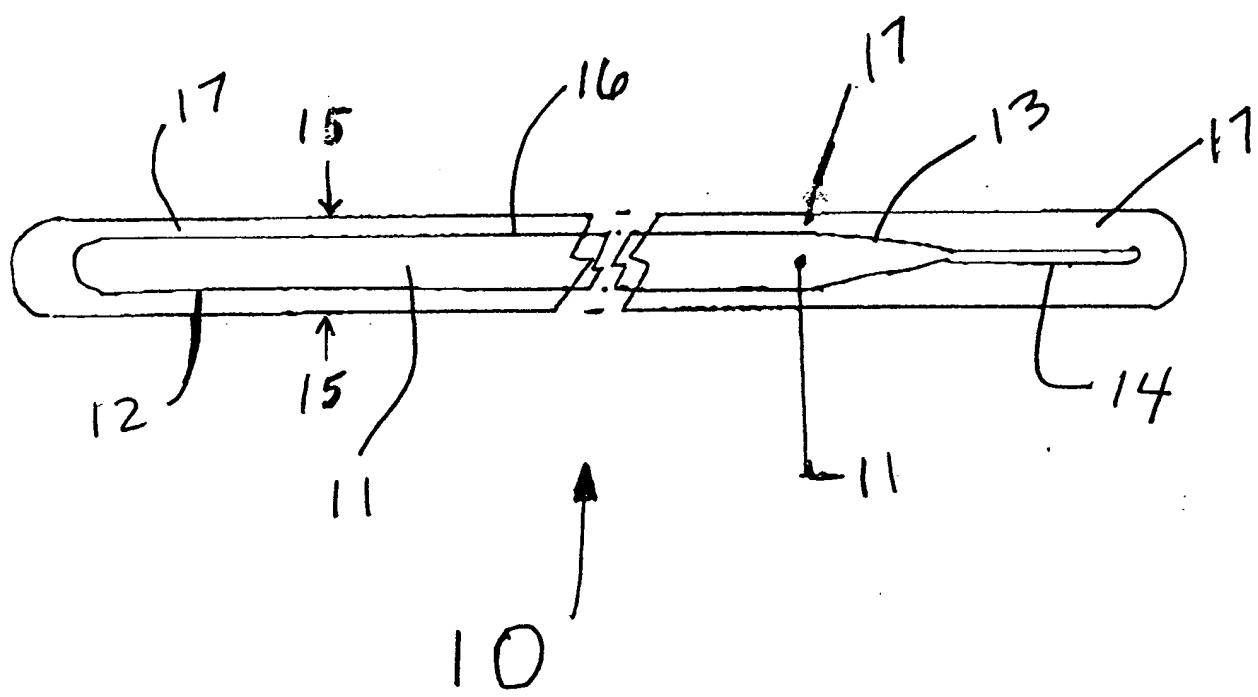
10. A guide wire comprising a core wire, the core wire having coupled proximal, medial, and distal segments, the core wire substantially completely comprising a polymeric material.
11. A guide wire according to claim 10 wherein the core wire is coated
5 with a second polymeric material.
12. A guide wire according to claim 10 wherein the core wire comprises carbon fiber.
13. A guide wire according to claim 10 wherein the core wire comprises polyetheretherketone.
- 10 14. A guide wire according to claim 10 wherein the core wire is coated with PEBA^X polyetherimide.
15. A guide wire according to claim 10 wherein the core wire comprises polyetheretherketone, and the core wire is coated with polyetherimide.
- 15 16. A guide wire according to claim 15 wherein the core wire distal segment is more flexible than either of the medial segment or the proximal segment.
17. A guide wire according to claim 15 wherein the core wire distal segment is coupled to the core wire medial segment through a tapered
20 segment and the distal segment has a diameter which is less than that of the medial segment.
18. A guide wire according to claim 10 wherein the polyetherimide coating has a hydrophilic coating thereover.

ABSTRACT OF THE INVENTION

5

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15



FIGURE

EXHIBIT 4

Page 1 of 13

Lake Region Manufacturing, Inc.

340 Lake Hazeltine Drive, Chaska, MN 55318 USA
FAX: 612-368-3378 TELEPHONE: 612-448-5111

TO: Grady Frenchick
MICHAEL, BEST & FRIEDRICH, LLP

FROM: Mark Fleischhacker, President/COO

DATE:

SUBJECT: Non-Metallic Guide Wire (See Attached)

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DRAFT

NON-METALLIC GUIDE WIRE

CROSS-REFERENCE TO RELATED APPLICATIONS

5 Not Applicable

BACKGROUND OF THE INVENTION

Guide wires are used in various medical procedures to gain vascular or
10 non-vascular access to anatomical locations. The guide wire is initially
introduced into the anatomy of a patient by means of a needle or other access
device which in many procedures pierces the patient's skin. The guide wire
is then advanced to a chosen or targeted anatomical location to provide a
means of tracking guidance and support for other diagnostic, interventional,
15 or therapeutic medical devices having lumens which can follow or track over
a guide wire. Once such other medical devices reach their desired anatomical
location, the guide wire is or can be withdrawn. The physician then proceeds
with the protocol of the procedure. A specific but non-limiting example of
the above is the placement of the balloon of a balloon catheter at the site of a
20 vascular blockage. Suffice it to say, guide wires are one of the most
commonly used medical devices where vascular or arterial access is desired.

United States patent 5,705,014 to Schenck et al. discloses and claims
methods for constructing instruments, specifically medical instruments,
intended for use during a magnetic resonance (MR) imaging procedure.
25 Essentially, the Schenck et al. '014 patent discloses methods for selecting
carbon fiber/substrate composite materials and for doping such composites
with materials of differing degrees of magnetization. In accordance with the
teaching of Schenck et al., the composite materials are doped so that medical
instruments manufactured from the doped composites do not interrupt the

MR imaging process or distort an image developed therefrom. The entirety of the disclosure of the Schenck et al. U.S. 5,705,014 patent is incorporated by reference herein. ^{5,251,640}

Discusses Cook 5,251,640

no recognition of
invention - suggests

metallic
components

BRIEF SUMMARY OF THE INVENTION

non - braided

Briefly, in one aspect, the present invention is an elongate guide wire comprising a guide wire body or core wire, the body having coupled or connected distal, medial, and proximal segments. The guide wire body of the present invention is substantially non-metallic, non-woven or non-braided, and preferably, is polymeric. In a preferred practice, a guide wire body of this invention is monofilament. A guide wire body of this invention, in a preferred practice, is substantially solid in cross-section throughout substantially its entire length. Guide wires of this invention are particularly useable during MR diagnostic and therapeutic procedures. In addition a guide wire of the present invention is camber and kink or prolapse resistant, as well as being pushable, steerable, and torque transmissive. These terms will be more extensively defined below.

The term "guide wire" as used herein is to be broadly construed to mean essentially any wire-like structure of dimension and length which is intended to assist in the placement of a catheter or other medical device at a site of medical interest. Percutaneous procedures in which placement of a catheter or other device through the skin and into the vasculature, are a preferred category of medical procedures in which guide wires are used. Guide wires herein is intended to include but is not limited to what is usually referred to as a guide wire, a main wire, introducer guide wires, diagnostic, therapeutic or interventional guide wires, wire guides, and spring guide wires, but also includes exchange guide wires and extension wires. Dimensions of guide wires to which the present invention primarily applies fall in the range

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Core
monofilament
non -
braided

10
Solid
core
not a
composite
15
wire
guide
solid?
non - fibrous

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hollow \Rightarrow

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of about 0.020 in. to about 0.065 in. in diameter and about 30 cm to about 300 cm (or more) in length. Without limiting the generality of the foregoing, peripheral, cerebral (including neuro-interventional), guide wires or wire guides are within the contemplation of this definition. Guide wires of the 5 present invention may include structure (e.g., on their extreme proximal segment) which permits them to be extended during a procedure by connection in a second (extension wire) guide wire. Guide wires of this invention also will generally have a reduced diameter, increased flexibility tip. Guide wires of this invention optionally may be coated or treated with 10 various further compositions, e.g., polymers or other compounds, to change their handling or performance characteristics such as to increase lubricity, or to reduce thrombogenicity of their external surface. Guide wires of the invention may also be uncoated.

A guide wire of the present invention is said to be "non-metallic". This 15 term is intended to mean containing or comprising no metals, alloys, or other materials which respond in some manner to the magnetic or radio frequency fields generated in an MR imaging system. This definition is intended to exclude non-ferrous metals which, while not necessarily interacting with the MR magnetic fields, exhibit what has become known as "antenna effect" by 20 interaction with the radio frequency fields used in that procedure. Thus magnetic field deflection and "antenna effect" are completely eliminated by the use of the present invention. A preferred class of materials which are non-metallic in accordance with this invention comprise polymeric materials. 25 Polymeric materials useable in the present invention predominantly are *essentially* substantially comprised of the elements of carbon and hydrogen.

BRIEF DESCRIPTION OF THE FIGURE

The present invention will now be discussed in detail, the understanding of which will be enhanced by reference to the attached 5 FIGURE which is a cross-sectional view (partially broken away) of one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

10 The invention will now be described with reference to the FIGURE noted above and the attached claims. The FIGURE shows a partially broken away, cross sectional view of one embodiment of the present invention. The FIGURE shows a guide wire 10 comprising a guide wire body or core wire 11 having a connected or coupled proximal segment 12, distal segment 14, 15 and a medial segment 16. It is to be understood that the medial segment will generally comprise the majority of the length of the guide wire 10 and has been broken as shown for purposes of illustrating other features of the invention. The terminology of proximal, medial, and distal, as it is used with reference to guide wire structures, will be well understood by one skilled in 20 this art to mean structures of the guide wire as determined from the user's perspective. More specifically, the distal segment 14 of a wire of this invention generally means that portion of the guide wire which first enters the patient's anatomy when the device is utilized. The distal segment 14 of any particular guide wire is generally designed to be more flexible than the rest of 25 the guide wire. In that regard, the distal segment 14 begins with a taper 13 in which the medial segment 16 of the guide wire body has a gradually reduced diameter. Taper 13 leads to distal segment 14 which, as shown in this embodiment has a lesser diameter than medial segment 16 or proximal

segment. Thus, distal segment 14 will generally be more flexible than medial segment 16.

The embodiment shown in the FIGURE includes an optional outer covering, coating, or jacket 17. Generally speaking jacket 17 will be a non-

5 metallic polymers

that of guide wi

17 is PEBAX p

are further exa

present inventio

10 coatings also ma

other coatings a

the present inve

overall diameter

The jacket 17 may be extruded using a radiopaque fill to enhance the visibility when used with imaging systems.

Guide wire body 11 is non-metallic, and in a preferred practice,

15 polymeric the overall diameter of the guide wire of at least the medial

segment shown in the FIGURE (at arrows 15) is 0.035 inches. Without

intending to limit the scope of the present invention, it is not preferred that the

present invention be used to build coronary-sized guide wires i.e., guide wires

having a diameter of about 0.020 inches or less. A preferred polymeric

20 material for guide wire body 11 is polyetheretherketone, sold under the

designation PEEK. PEEK as is used in accordance with this invention is

commercially available from many sources. A preferred source is Zeus

Industrial Products, Inc. in Orangeburg, South Carolina, U.S.A.

(<HTTP://www.zeusinc.com>) PEEK is preferred for use in the present

25 invention because it is camber resistant, having little tendency to break when

sharply bent. It is also thermally stable permitting other polymeric materials

to be extruded over it without change in dimension. PEEK is also capable

of being impregnated with glass fibers, e.g., to increase its longitudinal

stiffness. "Camber resistant" herein means having the property or tendency

Paragraph 20

Core matl. Fr m SGL Carb n Group

Carbon fibers laid straight longitudinally, or twisted 12 turns per foot. They are bundled with a vinylester resin and drawn through a die using a pull-trusion method described by SGL. We will then centerless grind the OD to the finished core size, and grind the distal end.

This can also be made with glass fiber using the same method in order to achieve a different feel and rigidity.

This can be made with different resins to achieve a different level of flexibility.

not be become curved when held in a circular package while being shipped. Camber resistance could als be described as not having the tendency to remain curved or circular even though guide wires are commercially shipped in circular carriers. The absence of camber means that medical personnel 5 using a device of this invention can remove it from its generally circular shipping tube (the device may have been maintained in a circular configuration for several months while the device was in inventory and being shipped) and still be immediately useable, e.g., for catheter placement.

Polyetheretherketone described above also has the property of not 10 being easily broken when sharply bent, e.g., around the human or other vasculature. PEEK also tends to resist prolapsing or to be kink resistant, i.e., becoming bent back upon itself. This is also an advantage of the use of PEEK to make the guide wire body of this invention. Last, as is noted above, the distal segment of a guide wire of the present invention is generally 15 more flexible than either of the proximal or medial segments. In this instance, the polymer used should preferably be capable of being centerless ground. Being capable of being centerless ground means that the reduced diameter distal segment (14 in the FIGURE) can easily be manufactured using conventional guide wire processing techniques.

20 A second material from which guide wire body 11 can comprise is a carbon fiber polymer commercially available from STL in Germany. [Aside *see a attached page* to Mark: I attempted to find something about STL on the Internet. I was not successful. Do you have any more information about the company e.g., an address, the product, a technical bulletin, etc.., so that 25 we can beef up this description of this class cor wire f materials? gif]

The polymeric materials which have been found to be useful for fabricating the guide wire core wire or guide wire body have properties which are representative of the properties of any polymeric material from which a guide wire of this invention is to be fabricated. Specifically, the polymeric

*SGL
Carbon
Group*

material must have sufficiently longitudinally rigidity or stiffness so that the guide wire can be advanced within a patient's vasculature in much the same fashion as e.g., a conventional 0.035 in. (diameter) metal angiography wire. As is noted above, the material must also be camber resistant while also being
5 resistant to prolapsing. Last, a workable polymeric material must be capable of being fabricated to have properties and "feel" like conventional metal, e.g., medical grade stainless steel, guide wires. In summary, polymeric materials from which the instant guide wire body or core wire can be fabricated are those that, with similar diameters, lengths, and coatings tend to perform in a
10 medical procedure substantially the same as their metallic counterparts.

It is to be noted that guide wire body 11 is substantially solid in section, substantially throughout its entire length. No interior lumens, or other void spaces are contemplated to be needed or necessary to practice the present invention presuming a polymeric material having the above
15 characteristics is selected to fabricate the guide wire body.

EXAMPLE

[Mark – Is there information from the University of Minnesota
20 trial that we can insert here?]

No information

CLAIMS

WHAT IS CLAIMED IS:

- 5 1. A guide wire comprising a core wire having coupled distal, medial and proximal segments, the core wire substantially comprising a non-metallic material.
- 10 2. A guide wire according to claim 1 wherein the core wire distal segment has a diameter which is less than that of the core wire medial and proximal segments.
- 15 3. A guide wire according to claim 1 wherein the diameters of the core wire distal, medial, and proximal segments are all substantially the same.
- 20 4. A guide wire according to claim 1 wherein the core wire has a polymeric coating thereon which covers substantially the entire length of the guide wire.
- 25 5. A guide wire according to claim 1 wherein core wire has a tapered segment between the medial segment and the distal segment.
- 30 6. A guide wire according to claim 1 wherein the core wire further comprises a taper which couples the medial segment and the distal segment and wherein substantially the entire core wire is covered with a polymeric material.
- 35 7. A guide wire according to claim 1 wherein the core wire comprises a polymeric material.
- 40 8. A guide wire according to claim 1 wherein the core wire comprises a polymeric material and the core wires is substantially completely covered with a second polymeric material.
- 45 9. A guide wire according to claim 1 wherein the distal segment of the core wire has a diameter which is less than that of the medial segment.

10. A guide wire comprising a core wire, the core wire having coupled proximal, medial, and distal segments, the core wire substantially completely comprising a polymeric material.

11. A guide wire acc⁵ n the core wire is coated with a second polymeric material. *Also glass fiber*

12. A guide wire . wherein the core wire comprises carbon fiber.

13. A guide wire according to claim 10 wherein the core wire comprises polyetheretherketone.

10 14. A guide wire according to claim 10 wherein the core wire is coated with PEBA^x polyetherimide.

15. A guide wire according to claim 10 wherein the core wire comprises polyetheretherketone, and the core wire is coated with polyetherimide.

15 16. A guide wire according to claim 15 wherein the core wire distal segment is more flexible than either of the medial segment or the proximal segment.

20 17. A guide wire according to claim 15 wherein the core wire distal segment is coupled to the core wire medial segment through a tapered segment and the distal segment has a diameter which is less than that of the medial segment.

18. A guide wire according to claim 10 wherein the polyetherimide coating has a hydrophilic coating thereover.

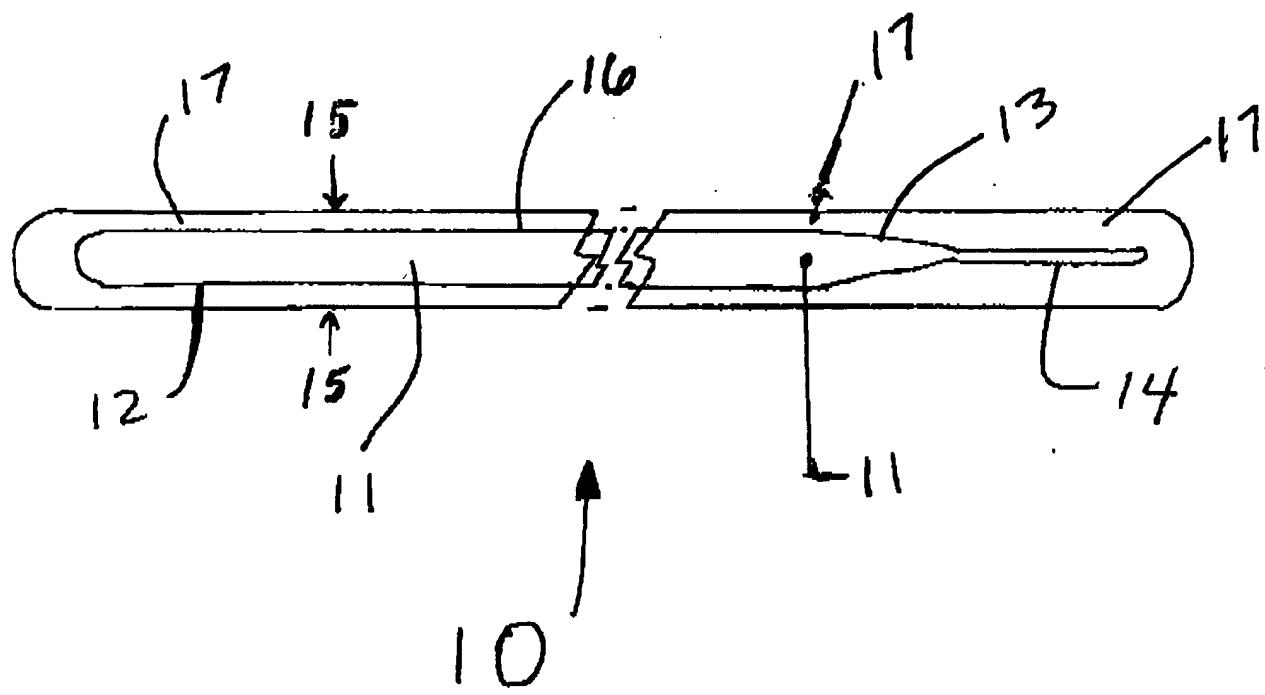
-10-

ABSTRACT OF THE INVENTION

5

10 e:\xf\client\58442\9191\scr2513.doc

15



FIGURE

EXHIBIT 5

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VIA FACSIMILE (952) 368-3378

Mr. Mark Fleischhacker
President/COO
Lake Region Manufacturing Co., Inc.
340 Lake Hazeltine Drive
Chaska, MN 55318

Re: Non-Metallic Non-Woven Guide Wire
File No. 58442.9191

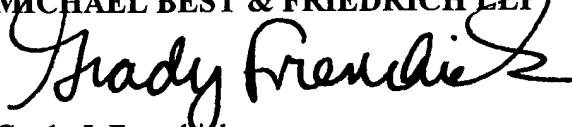
Dear Mark:

Enclosed for your consideration is a revision of the disclosure and claims of the subject application. Most of the revisions are relatively straightforward.

There is one matter that we will need to discuss, which is the helically-wound version of this invention. I wonder if you have either a hand-drawn or other depiction of the helically-wound version of this invention that I could use to include in the application. The helically-wound version is included in the disclosure but I think it needs to be illustrated.

I was discussing with Joe the possibility of visiting Lake Region in about two weeks. If that meets with his and your schedule I would like to discuss this matter at that time to see if we can bring this matter to closure.

Yours very truly,

MICHAEL BEST & FRIEDRICH LLP

Grady J. Frenchick

GJF:lir

Enclosures

Q:\CLIENT\58442\9191\B0005364

NON-METALLIC GUIDE WIRE

CROSS-REFERENCE TO RELATED APPLICATIONS

5 Not Applicable

BACKGROUND OF THE INVENTION

Guide wires are used in various medical procedures to gain vascular or
10 non-vascular access to anatomical locations. The guide wire is initially
introduced into the anatomy of a patient by means of a needle or other access
device which in many procedures pierces the patient's skin. The guide wire is
then advanced to a chosen or targeted anatomical location to provide a means of
tracking guidance and support for other diagnostic, interventional, or therapeutic
15 medical devices having lumens which can follow or track over a guide wire.
Once such other medical devices reach their desired anatomical location, the
guide wire is or can be withdrawn. The physician then proceeds with the
protocol of the procedure. A specific but non-limiting example of the above is
the placement of a balloon catheter at the site of a vascular blockage. Suffice it
20 to say, guide wires are one of the most commonly used medical devices where
vascular or arterial access is desired.

United States patent 5,705,014 to Schenck *et al.* discloses and claims
methods for constructing instruments, specifically medical instruments,
intended for use during a magnetic resonance (MR) imaging procedure.
25 Essentially, the Schenck *et al.* '014 patent discloses methods for selecting
carbon fiber/substrate composite materials and for doping such composites with
materials of differing degrees of magnetization. In accordance with the teaching

of Schenck *et al.*, the composite materials are doped so that medical instruments manufactured from the doped composites do not interrupt the MR imaging process or distort an image developed therefrom. The entirety of the disclosure of the Schenck *et al.* U.S. '014 patent is incorporated by reference herein.

5 United States patent 5,251,640 to Thomas A. Osbourne discloses a "Composite Wire Guide Shaft". The '640 patent discloses a composite guide shaft comprising a multifilar core (See FIGS. 3, 4, and 5) having multiple fibers wrapped therearound, the entire structure being held together by, for example, an adhesive matrix. In one embodiment of the device described in the '640 patent,

10 a hollow core wire guide is contemplated. Metal core wires are also discussed.

10 The disclosure of the '640 patent is also incorporated by reference herein.

BRIEF SUMMARY OF THE INVENTION

15 Briefly, in one aspect, the present invention is an elongate guide wire comprising a guide wire body or core wire, the body having coupled or connected distal, medial, and proximal segments. The guide wire body of the present invention is substantially non-metallic, non-woven, and non-braided. In a preferred practice a guide wire core wire of this invention is polymeric. In a preferred practice, a guide wire body of this invention is monofilament and is substantially solid in cross-section throughout substantially its entire length.

20

25 A guide wire of this invention optionally may include a non-metallic coil wire. Guide wires of this invention are particularly useable during MR diagnostic and therapeutic procedures. In addition a guide wire of the present invention is camber and kink or prolapse resistant, as well as being pushable, steerable, and torque transmissive. These terms will be more extensively defined below.

In a further embodiment of the present invention, the guide wire may comprise a non-metallic, helically-wound monofil or multifil core wire, or guide wire body embedded in a matrix material to provide a substantially solid (in cross-section) structure. A solid core wire structure of this aspect of the 5 present invention may further comprise a coating such as is more completely described below.

In an alternative embodiment, a helical core wire guide wire may comprise one or more helical non-metallic coil wires wound about the core wire. The helically-wound coil wires may be held in place by means of an adhesive. 10 The coil wire may be located adjacent any or all of the proximal, medial and distal segments of the guide wire. Usually the coil wire is axially disposed around the distal segment. The helically-wound coil wires of this further aspect of the present invention may be wound in the same or opposite directions. One skilled in the art will appreciate that the selection of fiber composition and 15 direction(s) of wind will significantly include the torque transmissive characteristics of the guide wire.

The term "guide wire" as used herein is to be broadly construed to mean essentially any wire-like structure of dimension and length which is intended to assist in the placement of a catheter or other medical device at a site of medical 20 interest. Percutaneous procedures in which placement of a catheter or other device through the skin and into the vasculature, are a preferred category of medical procedures in which guide wires are used. Guide wire herein is intended to include but is not limited to what is usually referred to as a guide wire, a main wire, introducer guide wires, diagnostic, therapeutic or 25 interventional guide wires, wire guides, and spring guide wires, but also includes exchange guide wires and extension wires. Dimensions of guide wires to which the present invention primarily applies fall in the range of about 0.020 in. to

about 0.065 in. in diameter and about 30 cm to about 300 cm (or more) in length. Without limiting the generality of the foregoing, peripheral, cerebral (including neuro-interventional), guide wires or wire guides are within the contemplation of this definition. Guide wires of the present invention may 5 include structure (e.g., on their extreme proximal segment) which permits them to be extended during a procedure by connection in a second (extension wire) guide wire. Guide wires of this invention also will generally have a reduced diameter, increased flexibility tip. Guide wires of this invention optionally may be coated or treated with various further compositions, e.g., polymers or other 10 compounds, to change their handling or performance characteristics such as to increase lubricity, to increase or decrease hydrophobicity, or to reduce thrombogenicity of their external surface. Guide wires of the invention may also be uncoated.

A guide wire of the present invention is said to be "non-metallic". This 15 term is intended to mean containing or comprising no metals, alloys, or other materials which respond in some manner to the magnetic or radio frequency fields generated in an MR imaging system. This definition is intended to exclude any non-ferrous metals which, while not necessarily interacting with the 20 MR magnetic fields, exhibit what has become known as "antenna effect" by interaction with the radio frequency fields used in that procedure. Thus magnetic field deflection and "antenna effect" are completely eliminated by the use of the present invention.

A preferred class of materials which are non-metallic in accordance with this invention comprise polymeric materials. Polymeric materials useable in the 25 present invention predominantly are substantially comprised of the elements of carbon and hydrogen, but can include oxygen, nitrogen, or other elements, usually as minor constituents.

BRIEF DESCRIPTION OF THE FIGURES

The present invention will now be discussed in detail, the understanding
5 of which will be enhanced by reference to the attached figures in which: FIG. 1
is a cross-sectional view (partially broken away) of one embodiment of the
present invention:

FIG. 2 is a second embodiment of the present invention.

FIG. 3 is a cross-section of the embodiment of the present invention
10 shown in FIG. 2.

[Mark – can you fax me a helical coil version of this invention?]

DETAILED DESCRIPTION OF THE INVENTION

15 The invention will now be described with reference to the FIGURE noted
above and the attached claims. The FIGURE shows a partially broken away,
cross sectional view of one embodiment of the present invention. The FIGURE
shows a guide wire 10 comprising a guide wire body or core wire 11 having a
connected or coupled proximal segment 12, distal segment 14, and a medial
20 segment 16. It is to be understood that the medial segment will generally
comprise the majority of the length of the guide wire 10 and has been broken as
shown for purposes of illustrating other features of the invention. The
terminology of proximal, medial, and distal, as it is used with reference to guide
wire structures, will be well understood by one skilled in this art to mean
25 structures of the guide wire as determined from the user's perspective. More
specifically, the distal segment 14 of a wire of this invention generally means
that portion of the guide wire which first enters the patient's anatomy when the

device is utilized. The distal segment 14 of any particular guide wire is generally designed to be more flexible than the rest of the guide wire. In that regard, the distal segment 14 begins with a taper 13 in which the medial segment 16 of the guide wire body has a gradually reduced diameter. Taper 13 leads to 5 distal segment 14 which, as shown in this embodiment has a lesser diameter than medial segment 16 or proximal segment. Thus, distal segment 14 will generally be more flexible than medial segment 16.

The embodiment shown in the FIGURE includes an optional outer covering, coating, or jacket 17. Generally speaking jacket 17 will be a non-metallic polymeric material, the polymer of coating 17 being different from that 10 of guide wire body 11. For example, one preferred polymer of coating 17 is PEBA^X polyetherimide. Polyurethane, nylon, polytetrafluoroethylene (PTFE) are further examples of optional coatings which could be used with the present invention. Extruded polymer coatings or other heat-shrunk polymer coatings 15 also may be utilized. A variety of other hydrophilic, hydrophobic or other coatings are known to one skilled in this art can optionally be used with the present invention. As is shown in FIG. 1, coating or jacket 17 tends to make the overall diameter (arrows 15) of the guide wire more uniform. Polymer coatings contemplated by the present invention optionally may include radiopaque fillers 20 such as barium salts in order to enhance the visibility of the guide wire when used with non-resonance imaging systems.

Guide wire body 11 is non-metallic, and in a preferred practice, polymeric. The overall diameter of the guide wire of at least the medial segment shown in FIG. 1 (at arrows 15) is approximately 0.035 inches. Without 25 intending to limit the scope of the present invention, it is not preferred that the present invention be used to build coronary-sized guide wires *i.e.*, guide wires having a diameter of about 0.020 inches or less. A preferred polymeric material

for guide wire body 11 polyetheretherketone, sold under the designation PEEK. PEEK as is used in accordance with this invention is commercially available from many sources. A preferred source is Zeus Industrial Products, Inc. in Orangeburg, South Carolina, U.S.A. (<HTTP://www.zeusinc.com>). PEEK is 5 preferred for use in the present invention because it is camber resistant, having little tendency to break when sharply bent. It is also thermally stable permitting other polymeric materials to be extruded over it without change in dimension. PEEK is also believed to be capable of being impregnated with glass fibers, *e.g.*, to alter its handling characteristics. "Camber resistant" herein means having the 10 property or tendency not to become curved when held in a circular package while being shipped. Camber resistance could also be described as not having the tendency to remain curved or circular even though guide wires are commercially shipped in circular carriers. The absence of camber means that medical personnel using a device of this invention can remove it from its 15 generally circular shipping tube (the device may have been maintained in a circular configuration for several months while the device was in inventory and being shipped) and still be immediately useable, *e.g.*, for catheter placement.

Polyetheretherketone described above also has the property of not being easily broken when sharply bent, *e.g.*, around human or other vasculature. 20 PEEK also tends to resist prolapsing or to be kink resistant, *i.e.*, becoming bent back upon itself. This is also an advantage of the use of PEEK to make the guide wire body of this invention. Last, as is noted above, the distal segment of a guide wire of the present invention is generally more flexible than either of the proximal or medial segments. In this instance, the polymer used should 25 preferably be capable of being centerless ground. Being capable of being centerless ground means that the reduced diameter distal segment (14 in the

FIGURE) can easily be manufactured using conventional guide wire processing techniques.

A second material from which guide wire body 11 can comprise is a carbon fiber commercially available from SGL Carbon Corp. of Charlotte, N.C., 5 U.S.A. The SGL Carbon fiber generally comprises bundled, helically-wound or twisted carbon fibers held together by means of an adhesive or other resin. A vinylester resin is a preferred adhesive or binder, the binder being applied by pultrusion of the wound carbon fibers or fiber bundles through a die. In a preferred practice of the present invention, the helically-wound guide wire body 10 has no more than 12 helical turns per foot, preferably no more than 10 helical turns per foot. Helically-wound glass fibers, with an appropriate binder or adhesive, are believed to be similarly useable. Nylon fibers, and "Isoplast" glass filled plastic fibers commercially available from Dow Chemical Corporation, are also believed to be useable in this structure. A structure so constructed can the 15 be centerless ground, *e.g.*, on the distal portion thereof, so as to reduce its diameter and increase its flexibility.

The ability to control the flexibility of the distal portion of a guide wire of the present invention using well-known centerless grinding processes is one of the surprising and unexpected advantages of the present invention. Centerless 20 grinding is a technique that is conventionally used to fabricate metallic guide wires. For example, centerless grinding is often used to reduce the diameter of a portion of a metal guide wire (*e.g.*, the distal portion of a guide wire core wire,) to increase distal tip flexibility. Centerless grinding was a technique that, prior to this invention, was not believed to be useable for non-metallic guide wires. 25 Centerless grinding of a portion of the guide wire body is much easier to accomplish than the use of staggered length, parallel, longitudinal fibers as is described in the above-mentioned Osbourne U.S. '640 patent at col. 3 line 20.

The polymeric materials which have been found to be useful for fabricating the guide wire core wire or guide wire body have properties which are representative of the properties of any polymeric material from which a guide wire of this invention is to be fabricated. Specifically, the polymeric 5 material must have sufficiently longitudinally rigidity or stiffness so that the guide wire can be advanced within a patient's vasculature in much the same fashion as *e.g.*, a conventional 0.035 in. (diameter) metal angiography wire. As is noted above, the material must also be camber resistant while also being 10 resistant to prolapsing. Last, a workable polymeric material must be capable of being fabricated to have properties and "feel" like conventional metal, *e.g.*, 15 medical grade stainless steel, guide wires. In summary, polymeric materials from which the instant guide wire body or core wire can be fabricated are those that, with similar diameters, lengths, and coatings tend to perform in a medical procedure substantially the same as their metallic counterparts.

It is to be noted that guide wire body 11 is substantially solid in section, substantially throughout its entire length. No interior lumens, or other void spaces are contemplated to be needed or necessary to practice the present invention presuming a polymeric material having the above characteristics is selected to fabricate the guide wire body.

It will be appreciated that guide wires of the present invention can be used 20 in situations where no magnetic resonance imaging is intended. The materials of the present invention are considerably less expensive than conventional materials of guide wires for similar applications. For example, guide wires of the present invention could be used to replace stainless steel diagnostic and 25 angiography guide wires. Guide wires of the present invention would be especially applicable for those procedures where no steerability is needed. Monofilament PIC wires, conventionally made of metal, also could be replaced

by the present invention. Many of the above non-MR imaging applications, where metal (including shape memory alloys) are used could be accomplished using the present invention.

CLAIMS

WHAT IS CLAIMED IS:

- 5 1. A guide wire comprising a core wire having coupled distal, medial and proximal segments, the core wire substantially comprising a non-metallic, non-woven, material.
- 10 2. A guide wire according to claim 1 wherein the core wire distal segment has a diameter which is less than that of the core wire medial and proximal segments.
- 15 3. A guide wire according to claim 1 wherein the diameters of the core wire distal, medial, and proximal segments are all substantially the same.
- 20 4. A guide wire according to claim 1 wherein the core wire has a polymeric coating thereon which covers substantially the entire length of the guide wire.
- 25 5. A guide wire according to claim 1 wherein core wire has a tapered segment between the medial segment and the distal segment.
- 30 6. A guide wire according to claim 1 wherein the core wire further comprises a taper which couples the medial segment and the distal segment and wherein substantially the entire core wire is covered with a polymeric material.
- 35 7. A guide wire according to claim 1 wherein the core wire comprises a polymeric material.
- 40 8. A guide wire according to claim 1 wherein the core wire comprises a polymeric material and the core wire is substantially completely covered with a second polymeric material.
- 45 9. A guide wire according to claim 1 wherein the distal segment of the core wire has a diameter which is less than that of the medial segment.

10. A guide wire comprising a core wire, the core wire having coupled proximal, medial, and distal segments, the core wire substantially completely comprising a polymeric material.

11. A guide wire according to claim 10 wherein the core wire is coated
5 with a second polymeric material.

12. A guide wire according to claim 10 wherein the core wire comprises carbon fiber.

13. A guide wire according to claim 10 wherein the core wire comprises polyetheretherketone.

10 14. A guide wire according to claim 10 wherein the core wire is coated with PEBA^X polyetherimide.

15. A guide wire according to claim 10 wherein the core wire comprises polyetheretherketone, and the core wire is coated with polyetherimide.

16. A guide wire according to claim 15 wherein the core wire distal
15 segment is more flexible than either of the medial segment or the proximal segment.

20 17. A guide wire according to claim 15 wherein the core wire distal segment is coupled to the core wire medial segment through a tapered segment and the distal segment has a diameter which is less than that of the medial segment.

18. A guide wire according to claim 10 wherein the polyetherimide coating has a hydrophilic coating thereover.

25 19. A guide wire comprising a core wire having coupled distal, medial, and proximal segments, the core wire comprising multiple, helically-wound, non-metallic fibers and a binder resin, the binder resin being uniformly dispersed between the fibers so as to fill any void space therebetween.

20. A guide wire according to claim 19 which further comprises a coil wire disposed about the distal segment.

21. A guide wire according to claim 19 where the non-metallic fibers comprise carbon and the binder resin comprises a vinyl ester.

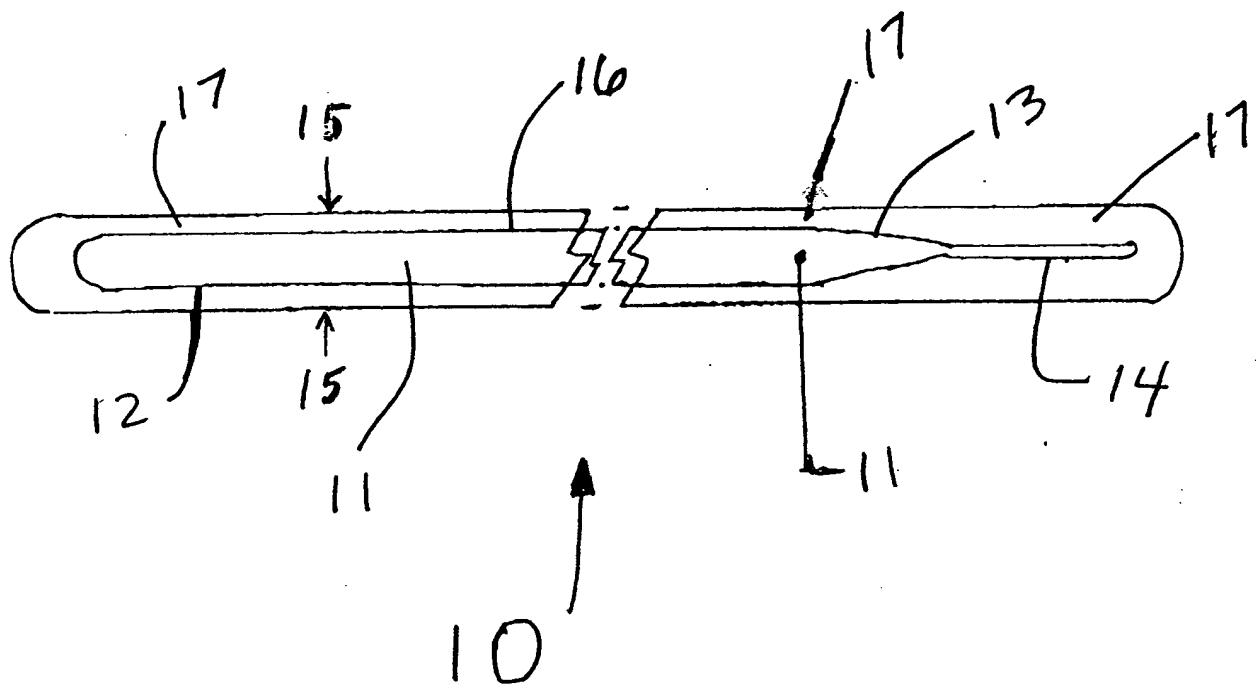
5 22. A guide wire according to claim 19 wherein the helically-wound fibers are wound to no more than 10 helices per foot of guide wire length.

10 23. A guide wire comprising a core wire having coupled, distal, medial and proximal segments, the core wire comprising a single helically-wound non-metallic fiber and a binder resin, the binder resin being uniformly dispersed between the helices of the fiber so as to fill any void space therebetween and to provide steerability and torqueability to the guide wire.

24. A guide wire according to claim 23 which further includes a coil wire disposed about the distal segment.

ABSTRACT OF THE DISCLOSURE

A guide wire having a non-metallic, non-woven core wire is disclosed. Monofilar, polymeric fibers of multifilar helically-wound non-metallic fibers are 5 a preferred core wire materials. The guide wire optionally includes further coatings and other materials on the core wire. In one embodiment, a non-metallic distal coil wire is disclosed. The guide wire of this invention is particularly useable for magnetic resonance imaging applications.



FIGURE

EXHIBIT 6

Page 1 of 6 *Re*

LAKE REGION MANUFACTURING, INC.
340 Lake Hazeltine Drive, Chaska, MN 55318 USA
FAX: 612-368-3378 TELEPHONE: 612-448-5111

TO: Grady Frenchick **FAX:** 608-283-2275
MICHAEL, BEST AND FRIEDRICH LLP

FROM: Mark Fleischhacker, President/COO

DATE:

SUBJECT: Suggestions/Edits Regarding Non-Metallic,
Non-Woven Guide Wire (Patent #58442.9191)

Confidentiality Notice: The document(s) accompanying this fax contains confidential information which may be legally privileged. The information is intended only for the use of the intended recipient named above. If you are not the intended recipient, you are hereby notified that any disclosure, copying, distribution or that taking of any action in reliance on the contents of this telecopied information except its direct delivery of the intended recipient named above is strictly prohibited. If you have received this fax in error, please notify us immediately by telephone to arrange for return of the original documents to us.

Dear Grady:

Attached are suggestions/edits to your fax of

Please review and let me know your

thoughts.

Sincerely,

Mark Fleischhacker

Mark Fleischhacker
President/COO

MF/sb

Attachment

SUGGESTIONS/EDITS

Page 4, Paragraph 25:

I do not understand the reference of: "carbon and hydrogen, but can include oxygen, nitrogen or other elements." Is this relevant? Why is this in the document?

Page 6, Paragraph 25, &

Page 3, Paragraph 25:

Let's not limit the diameter to .035 inch. We want to go down to .012 inch. Primarily fall within the range of .012 to .065 inch.

Page 13, Claim 22:

Should read: "Fibers are wound to at least 10 helices per linear foot of guide wire length."

Page 8, Paragraph 10:

✓ Edit: "no more than 12, preferably no more than ten"
Change to: "at least 10 turns"

Page 2, Paragraph 15:

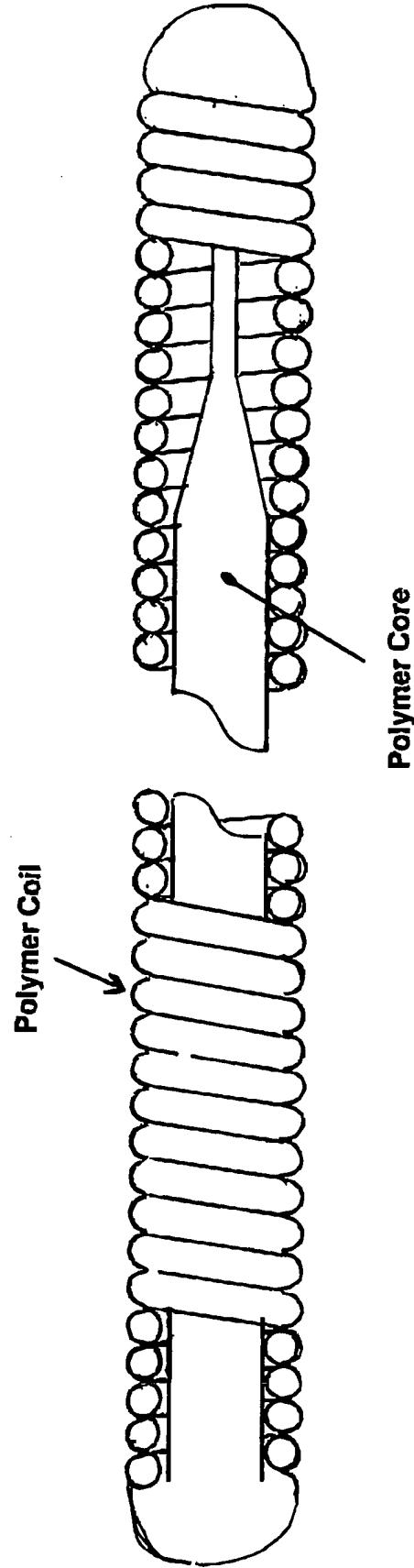
This paragraph and paragraphs 10 on page 3, and 5 on page 6, claim 1, describes the device as having coupled or connected distal, medial and proximal segments which makes it sound like separate pieces rather than one piece. Why is this the case?

Page 2, Paragraph 21:

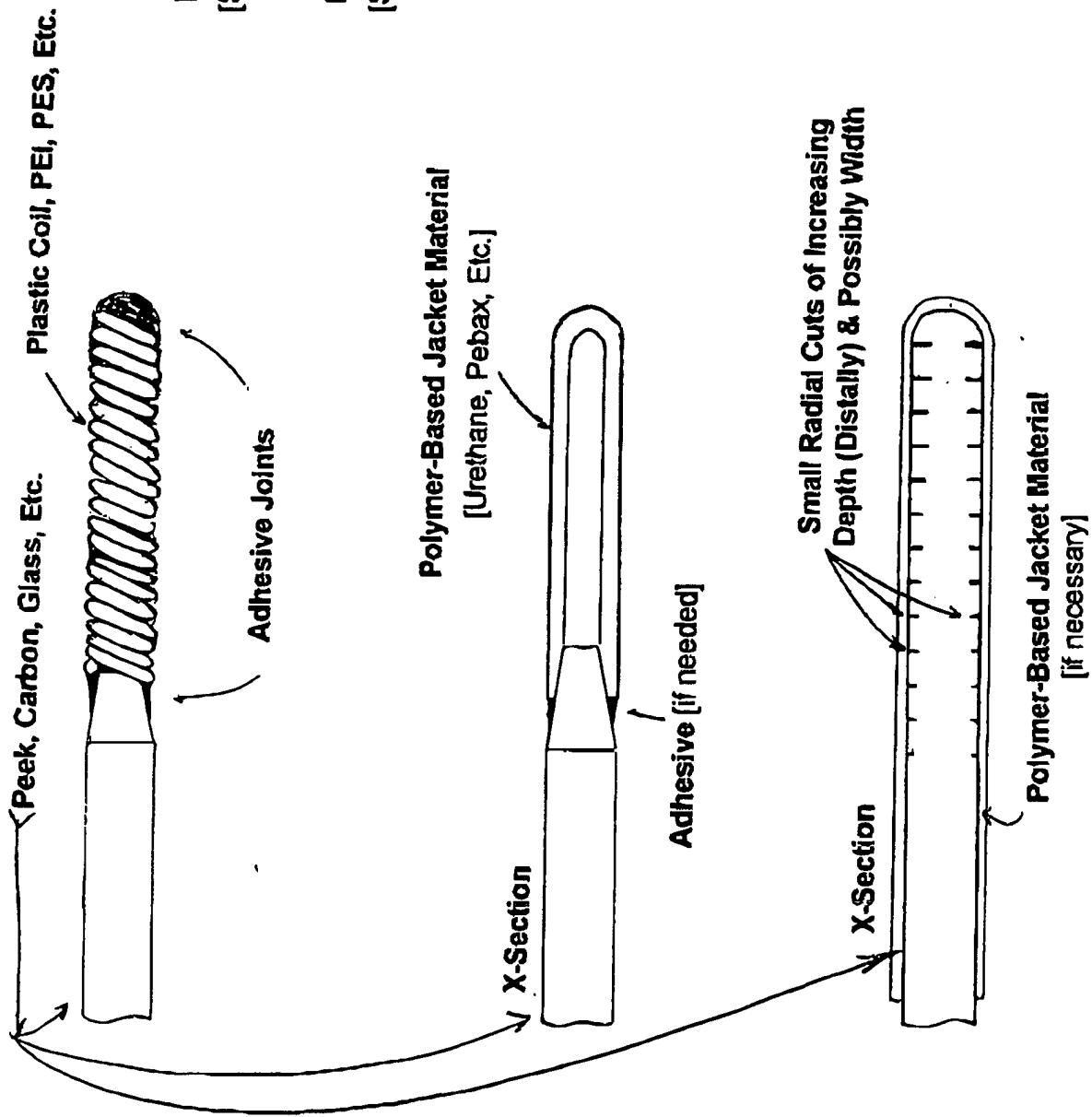
✓ We want it to be kink resistant. We want prolaps capability without kinking.

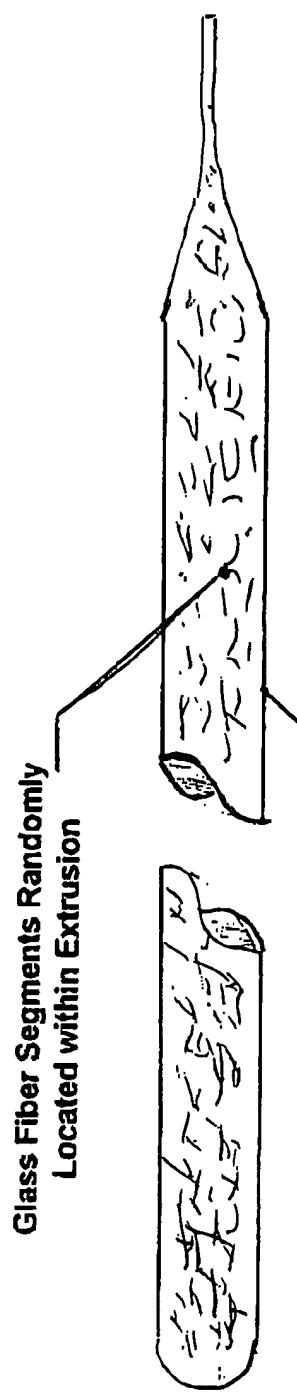
Page 7, Paragraph 20:

✓ Allows prolapsing without kinking or fracturing.



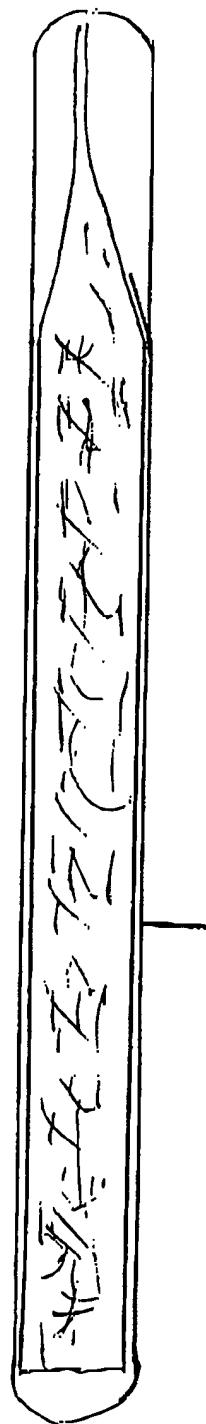
Helix Coil Version of Invention
[Ref. Pg. 5, Line 11]





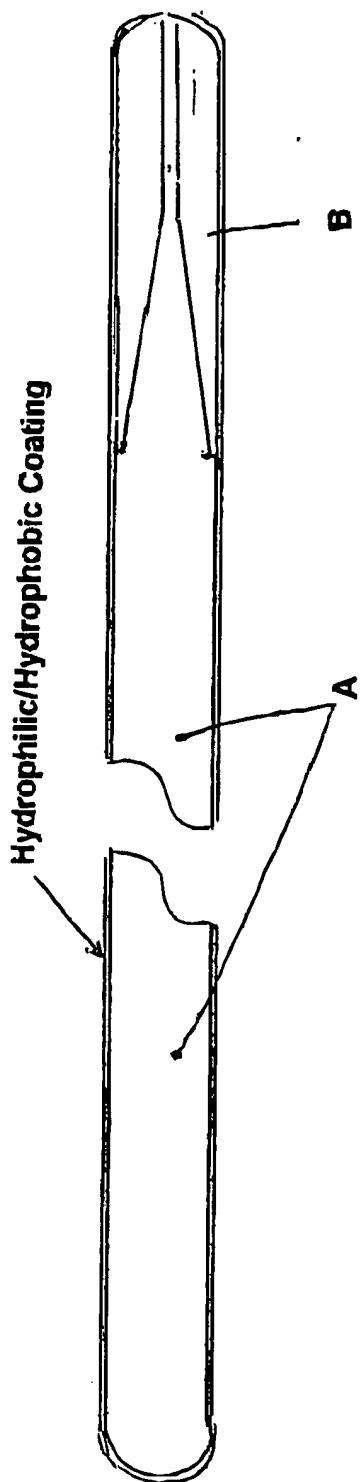
Polymer Core Made of Peek or Similar Material

Polymer Core with Glass Segmented Fibers Randomly Located within Extrusion



Polymer Extrusion Over Glass-Filled Core Extrusion

[Could have a Hydrophilic coating or other lubricious coating on exterior surface.]



Mono Filament Guide Body (A) with Centerless Ground Tip

[Polymer molded over distal grind creating a continuous OD over entire length. Mono-filament material could be Peek, glass-filled Peek, Isoplast®, nylon or filled-nylon, or similar material.]

EXHIBIT 7

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P.O. Box 1806
Madison, WI 53701-1806
Telephone (608) 257-3501
FAX (608) 283-2275

FACSIMILE TRANSMISSION

DATE:

To:

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FROM: Grady J. Frenchick

PHONE: (608) 283-0109

SENT BY: Leslie R.

EXTENSION: 7514

LOCATION: Madison, WI

RE: Draft of NON-METALLIC GUIDE WIRE patent application

NUMBER OF PAGES, INCLUDING COVER:	19		
CLIENT MATTER NUMBER:	58442.9191	SENDER'S ACCOUNT NUMBER:	822

NOTES/COMMENTS:

For possible discussion on Friday (or next week). GJF

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8:30 PM

Please edit as shown & RAS
to Mark Fleschhacker

NON-METALLIC GUIDE WIRE

Message: For possible discussion on
Friday (or next week).

CROSS-REFERENCE TO RELATED APPLICATIONS

5 Not Applicable

BACKGROUND OF THE INVENTION

Guide wires are used in various medical procedures to gain vascular or
10 non-vascular access to anatomical locations. The guide wire is initially
introduced into the anatomy of a patient by means of a needle or other access
device which in many procedures pierces the patient's skin. The guide wire is
then advanced to a chosen or targeted anatomical location to provide a means of
tracking guidance and support for other diagnostic, interventional, or therapeutic
15 medical devices having lumens which can follow or track over a guide wire.
Once such other medical devices reach their desired anatomical location, the
guide wire is or can be withdrawn. The physician then proceeds with the
protocol of the procedure. A specific but non-limiting example of the above is
the placement of a balloon catheter at the site of a vascular blockage. Suffice it
20 to say, guide wires are one of the most commonly used medical devices where
vascular or arterial access is desired.

United States patent 5,705,014 to Schenck *et al.* discloses and claims
methods for constructing instruments, specifically medical instruments,
intended for use during a magnetic resonance (MR) imaging procedure.
25 Essentially, the Schenck *et al.* '014 patent discloses methods for selecting
carbon fiber/substrate composite materials and for doping such composites with
materials of differing degrees of magnetization. In accordance with the teaching

of the disclosure of the Schenck *et al.* U.S. '014 patent is incorporated by reference herein. United States patent 5,251,640 to Thomas A. Osbourne discloses a "Composite Wire Guide Shaft". The '640 patent discloses a composite guide shaft comprising a multifilar core (See FIGS. 3, 4, and 5) 5 having multiple fibers wrapped therearound, the entire structure being held together by, for example, an adhesive matrix. In one embodiment of the device described in the '640 patent, a hollow core wire guide is contemplated. Metal core wires are also discussed. The disclosure of the '640 patent is also incorporated by reference herein.

10

BRIEF SUMMARY OF THE INVENTION

Briefly, in one aspect, the present invention is an elongate guide wire comprising a guide wire body or core wire, the body having distal, medial, 15 and proximal segments or portions. The guide wire body of the present invention is substantially non-metallic, non-woven, and non-braided. In a preferred practice a guide wire core wire of this invention is polymeric. In a preferred practice, a guide wire body of this invention is monofilament and is substantially solid in cross-section throughout substantially its entire length.

20 A guide wire of this invention optionally may include a non-metallic coil wire. Guide wires of this invention are particularly useable during MR diagnostic and therapeutic procedures. In addition a guide wire of the present invention is kink resistant having the ability to prolapse, *i.e.*, to be bent backward, without kinking. A guide wire of this invention also is pushable, 25 steerable, and torque transmissive, primarily from its proximal end. These terms will be more extensively defined below.

In a further embodiment of the present invention, the guide wire may comprise a non-metallic, helically-wound monofil or multifilar core wire, or guide wire body embedded in a matrix material to provide a substantially

solid (in cross-section) structure. A solid core wire structure of this aspect of the present invention may further comprise a coating such as is more completely described below.

In an alternative embodiment, a helical core wire guide wire may 5 comprise one or more helical non-metallic coil wires wound about the core wire. The helically-wound coil wires may be held in place by means of an adhesive. The coil wire may be located adjacent any or all of the proximal, medial and distal segments of the guide wire. Usually the coil wire is axially 10 or radially disposed around the distal segment. The helically-wound coil wires of this further aspect of the present invention may be wound in the same or opposite directions. One skilled in the art will appreciate that the selection of fiber composition and direction(s) of wind will significantly include the torque transmissive characteristics of the guide wire.

The term "guide wire" as used herein is to be broadly construed to 15 mean essentially any wire-like structure of dimension and length which is intended to assist in the placement of a catheter or other medical device at a site of medical interest. Percutaneous procedures in which placement of a catheter or other device through the skin and into the vasculature, are a preferred category of medical procedures in which guide wires are used. 20 Guide wire herein is intended to include but is not limited to what is usually referred to as a guide wire, a main wire, introducer guide wires, diagnostic, therapeutic or interventional guide wires, wire guides, and spring guide wires, but also includes exchange guide wires and extension wires. Dimensions of 25 guide wires to which the present invention primarily applies fall in the range of about 0.012 in. to about 0.065 in. in diameter and about 30 cm to about 300 cm (or more) in length. Without limiting the generality of the foregoing, peripheral, cerebral (including neuro-interventional), guide wires or wire guides are within the contemplation of this definition. Guide wires of the present invention may include structure (e.g., on their extreme proximal

segment) which permits them to be extended during a procedure by connection in a second (extension wire) guide wire. Guide wires of this invention also will generally have a reduced diameter, increased flexibility tip. Guide wires of this invention optionally may be coated or treated with 5 various further compositions, *e.g.*, polymers or other compounds, to change their handling or performance characteristics such as to increase lubricity, to increase or decrease hydrophobicity, or to reduce thrombogenicity of their external surface. Guide wires of the invention may also be uncoated.

A guide wire of the present invention is said to be "non-metallic". This 10 term is intended to mean containing or comprising no metals, alloys, or other materials which respond in some manner to the magnetic or radio frequency fields generated in an MR imaging system. This definition is intended to exclude any non-ferrous metals which, while not necessarily interacting with the MR magnetic fields, exhibit what has become known as "antenna effect" 15 by interaction with the radio frequency fields used in that procedure. Thus magnetic field deflection and "antenna effect" are completely eliminated by the use of the present invention.

A preferred class of materials, which is non-metallic in accordance with this invention, comprises polymeric materials. Polymeric materials 20 useable in the present invention are preferably hydrocarbon-based comprised of the elements of carbon and hydrogen. However, hydrocarbon polymer is useable in the present invention can, and often will, include oxygen, nitrogen, or other elements, usually as minor constituents.

BRIEF DESCRIPTION OF THE FIGURES

The present invention will now be discussed in detail, the
5 understanding of which will be enhanced by reference to the attached figures
in which:

FIG. 1 is a cross-sectional view (partially broken away) of one embodiment of the present invention:

10 FIG. 2 is a second embodiment of the present invention in which a polymeric core and polymeric guide wire coil are used.

FIG. 3 is a further embodiment of the present invention in which a polymeric coil is disposed on the distal end of the guide wire core wire.

15 FIG. 4 is a cross sectional view of another embodiment of the present invention in which a polymeric jacket material is disposed on the distal end of the guide wire core wire.

FIG. 5 is a cross sectional view of a further embodiment of the present invention in which a substantially uniform diameter polymeric guide wire core which has been partially radially cut or scored to increase distal segment or distal tip flexibility.

20 FIG. 6 illustrates a guide wire core structure of the present invention comprising a polymeric core material in which there is disposed glass fiber segments and an optional external coating.

DETAILED DESCRIPTION OF THE INVENTION

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The invention will now be described with reference to the FIGs. noted above and the attached claims. FIG. 1 shows a partially broken away, cross sectional view of one embodiment of the present invention. FIG. 1 shows a guide wire 10 comprising a guide wire body or core wire 11 having a

proximal segment 12, distal segment 14, and a medial segment 16. It is to be understood that the medial segment will generally comprise the majority of the length of the guide wire 10 and has been broken as shown for purposes of illustrating other features of the invention. The terminology of proximal, 5 medial, and distal, as it is used with reference to guide wire structures, will be well understood by one skilled in this art to mean structures of the guide wire as determined from the user's perspective. More specifically, the distal segment 14 of a wire of this invention generally means that portion of the guide wire which first enters the patient's anatomy when the device is 10 utilized. The distal segment 14 of any particular guide wire is generally designed to be more flexible than the rest of the guide wire. In that regard, the distal segment 14 begins with a taper 13 in which the medial segment 16 of the guide wire body has a gradually reduced diameter. Taper 13 leads to distal segment 14, which, as shown in this embodiment has a lesser diameter 15 than medial segment 16, or proximal segment. Thus, distal segment 14 will generally be more flexible than medial segment 16. The diameter of distal segment 14 may be reduced, for example, by centerless grinding

The embodiment shown in the FIG. 1 includes an optional outer covering, coating, or jacket 17. Generally speaking jacket 17 will be a non-metallic polymeric material, the polymer of coating 17 being different from that of guide wire body 11. For example, one preferred polymer of coating 20 17 is PEBA_X polyetherimide. Polyurethane, nylon, and polytetrafluoroethylene (PTFE) are further examples of optional coatings which could be used with the present invention. Extruded polymer coatings 25 or other heat-shrunk polymer coatings also may be utilized. A variety of other hydrophilic, hydrophobic or other coatings that are known to one skilled in this art can optionally be used with the present invention. As is shown in FIG. 1, coating or jacket 17 tends to make the overall diameter (arrows 15) of the guide wire more uniform. Polymer coatings contemplated

by the present invention optionally may include radiopaque fillers such as barium salts in order to enhance the visibility of the guide wire when used with non-resonance imaging systems.

Guide wire body 11 is non-metallic, and in a preferred practice, 5 polymeric. The overall diameter of the guide wire of at least the medial segment shown in FIG. 1 (at arrows 15) is approximately 0.035 inches. A preferred polymeric material for guide wire body 11 polyetheretherketone, sold under the designation PEEK. PEEK as is used in accordance with this invention is commercially available from many sources. A preferred source 10 is Zeus Industrial Products, Inc. in Orangeburg, South Carolina, U.S.A. (<HTTP://www.zeusinc.com>). PEEK is preferred for use in the present invention because it is camber resistant, having little tendency to break when sharply bent. It is also thermally stable permitting other polymeric materials to be extruded over it without change in dimension. PEEK is also believed to 15 be capable of being impregnated with glass fibers, *e.g.*, to alter its handling characteristics. "Camber resistant" herein means having the property or tendency not to become curved when held in a circular package while being shipped. Camber resistance could also be described as not having the tendency to remain curved or circular even though guide wires are 20 commercially shipped in circular carriers. The absence of camber means that medical personnel using a device of this invention can remove it from its generally circular shipping tube (the device may have been maintained in a circular configuration for several months while the device was in inventory and being shipped) and still be immediately useable, *e.g.*, for catheter 25 placement.

Polyetheretherketone described above also has the property of not being easily broken when sharply bent, *e.g.*, around human or other vasculature. PEEK also tends to allow prolapsing without kinking or fracturing. This is also an advantage of the use of PEEK to make the guide

wire body of this invention. Last, as is noted above, the distal segment of a guide wire of the present invention is generally more flexible than either of the proximal or medial segments. In this instance, the polymer used should preferably be capable of being centerless ground. Being capable of being 5 centerless ground means that the reduced diameter distal segment (14 in the FIG. 1) can easily be manufactured using conventional guide wire processing techniques.

A second material from which guide wire body 11 can comprise is a carbon fiber commercially available from SGL Carbon Corp. of Charlotte, 10 N.C., U.S.A. The SGL Carbon fiber generally comprises bundled, helically-wound or twisted carbon fibers held together by means of an adhesive or other resin. A vinylester resin is a preferred adhesive or binder, the binder being applied by pultrusion of the wound carbon fibers or fiber bundles through a die. In a preferred practice of the present invention, the helically-wound guide wire body has at least 10 helical turns per foot. Helically-wound glass fibers, with an appropriate binder or adhesive, are believed to be 15 similarly useable. Nylon fibers, and "Isoplast" glass filled plastic fibers commercially available from Dow Chemical Corporation, are also believed to be useable in this structure. A structure so constructed can be centerless ground, *e.g.*, on the distal portion thereof, so as to reduce its diameter and 20 increase its flexibility.

The ability to control the flexibility of the distal portion of a guide wire of the present invention using well-known centerless grinding processes is one of the surprising and unexpected advantages of the present invention. 25 Centerless grinding is a technique that is conventionally used to fabricate metallic guide wires. For example, centerless grinding is often used to reduce the diameter of a portion of a metal guide wire (*e.g.*, the distal portion of a guide wire core wire), to increase distal tip flexibility. Centerless grinding was a technique that, prior to this invention, was not believed to be useable

for non-metallic guide wires. Centerless grinding of a portion of the guide wire body is much easier to accomplish than the use of staggered length, parallel, longitudinal fibers as is described in the above-mentioned Osbourne U.S. '640 patent at col. 3 line 20.

5 The polymeric materials which have been found to be useful for fabricating the guide wire core wire or guide wire body have properties which are representative of the properties of any polymeric material from which a guide wire of this invention is to be fabricated. Specifically, the polymeric material must have sufficiently longitudinal rigidity or stiffness so that the
10 guide wire can be advanced within a patient's vasculature in much the same fashion as *e.g.*, a conventional 0.035 in. (diameter) metal angiography wire. As is noted above, the material must also be camber resistant while also being resistant to prolapsing. Last, a workable polymeric material must be capable of being fabricated to have properties and "feel" like conventional metal, *e.g.*,
15 medical grade stainless steel, guide wires. In summary, polymeric materials from which the instant guide wire body or core wire can be fabricated are those that, with similar diameters, lengths, and coatings tend to perform in a medical procedure substantially the same as their metallic counterparts.

It is to be noted that guide wire body 11 is substantially solid in
20 section, substantially throughout its entire length. No interior lumens, or other void spaces are contemplated to be needed or necessary to practice the present invention presuming a polymeric material having the above characteristics is selected to fabricate the guide wire body.

FIG. 2 illustrates a second embodiment of the present invention
25 wherein the guide wire comprises a solid guide wire core wire 50 comprises a polymeric material as disclosed herein with a polymeric coil wire 52 substantially disposed therearound. Core wire 50 and coil 52 may be attached to each other by any means suitable for adhering one polymeric material to another. For example, an adhesive may be used (at 54 and 56) to

bond the guide wire components to each other. It is to be noted that coil wire 52 is wound around substantially the entire length of core wire 50 in this embodiment of the invention.

FIG. 3 is a further embodiment of the present invention in which a 5 polymeric coil wire 60 is disposed on just the distal segment 62 of core wire 64. Polymeric or plastic coil wire materials include PEI (polyetherimide commercially available from General Electric Plastics and sold under the trade designation "Ultem"), PES (polyether sulfone commercially available from BASF under the trade designation "Ultrason") and various other high 10 performance polymeric materials the identities of which would occur to one skilled in this art in view of this disclosure. Polymeric core 64 may comprise PEEK or carbon fiber as is described above. Adhesive joints 66 bind the coil wire to the core wire.

FIG. 4 illustrates a variation of the structure shown in FIG. 3 in which 15 a polymer-based jacket material 70 is disposed on the distal segment 72 of guide wire core wire 74. An optional adhesive 76 may be used to adhere jacket material 70 to core wire 74. Illustrative polymeric jacket materials include, polyurethane and Pebax as is described above.

FIG. 5 illustrates a further embodiment of the present invention in 20 which the distal segment 80 of polymeric guide wire core wire 82 has been made more flexible by cutting or etching therein a series of radial cuts 84. As will be understood (and as is illustrated), the depth and distance between cuts 84 may be adjusted to increase or decrease the flexibility of distal segment 80. The width of the cuts 84 also may be increased or decreased to change 25 device tip flexibility. Also as is shown, an optional polymer-based coating 86 is disposed over distal segment 80. Polymer coating 86 may be disposed over all or part of core wire 82 as is well known in the art.

FIG. 6 illustrates a further embodiment of the present invention in which a polymer guide wire core 90 has randomly disposed therein fibrous

CLAIMS

WHAT IS CLAIMED IS:

- 5 1. A guide wire comprising a core wire having distal, medial and proximal segments, the core wire substantially comprising a non-metallic, non-woven, material.
- 10 2. A guide wire according to claim 1 wherein the core wire distal segment has a diameter which is less than that of the core wire medial and proximal segments.
- 15 3. A guide wire according to claim 1 wherein the diameters of the core wire distal, medial, and proximal segments are all substantially the same.
- 20 4. A guide wire according to claim 1 wherein the core wire has a polymeric coating thereon which covers substantially the entire length of the guide wire.
- 25 5. A guide wire according to claim 1 wherein core wire has a tapered segment between the medial segment and the distal segment.
- 30 6. A guide wire according to claim 1 wherein the core wire further comprises a taper which couples the medial segment and the distal segment and wherein substantially the entire core wire is covered with a polymeric material.
- 35 7. A guide wire according to claim 1 wherein the core wire comprises a polymeric material.
- 40 8. A guide wire according to claim 1 wherein the core wire comprises a polymeric material and the core wire is substantially completely covered with a second polymeric material.
- 45 9. A guide wire according to claim 1 wherein the distal segment of the core wire has a diameter which is less than that of the medial segment.

10. A guide wire comprising a core wire, the core wire having coupled proximal, medial, and distal segments, the core wire substantially completely comprising a polymeric material.

11. A guide wire according to claim 10 wherein the core wire is coated
5 with a second polymeric material.

12. A guide wire according to claim 10 wherein the core wire comprises carbon fiber.

13. A guide wire according to claim 10 wherein the core wire comprises polyetheretherketone.

10 14. A guide wire according to claim 10 wherein the core wire is coated with PEBA^X polyetherimide.

15 15. A guide wire according to claim 10 wherein the core wire comprises polyetheretherketone, and the core wire is coated with polyetherimide.

15 16. A guide wire according to claim 15 wherein the core wire distal segment is more flexible than either of the medial segment or the proximal segment.

20 17. A guide wire according to claim 15 wherein the core wire distal segment is coupled to the core wire medial segment through a tapered segment and the distal segment has a diameter which is less than that of the medial segment.

18. A guide wire according to claim 10 wherein the polyetherimide coating has a hydrophilic coating thereover.

25 19. A guide wire comprising a core wire having coupled distal, medial, and proximal segments, the core wire comprising multiple, helically-wound, non-metallic fibers and a binder resin, the binder resin being uniformly dispersed between the fibers so as to fill any void space therebetween.

20. A guide wire according to claim 19 which further comprises a coil wire disposed about the distal segment.

21. A guide wire according to claim 19 where the non-metallic fibers comprise carbon and the binder resin comprises a vinyl ester.
22. A guide wire according to claim 19 wherein the helically-wound fibers are wound to no more than 10 helices per foot of guide wire length.
- 5 23. A guide wire comprising a core wire having coupled, distal, medial and proximal segments, the core wire comprising a single helically-wound non-metallic fiber and a binder resin, the binder resin being uniformly dispersed between the helices of the fiber so as to fill any void space therebetween and to provide steerability and torqueability to the guide wire.
- 10 24. A guide wire according to claim 23 which further includes a coil wire disposed about the distal segment.

ABSTRACT OF THE DISCLOSURE

A guide wire having a non-metallic, non-woven core wire is disclosed. Monofilar, polymeric fibers of multifilar helically-wound non-metallic fibers 5 are preferred core wire materials. The guide wire optionally includes further coatings and other materials on the core wire. In one embodiment, a non-metallic distal coil wire is disclosed. The guide wire of this invention is particularly useable for magnetic resonance imaging applications.

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